Center Independent Research & Development: KSC IRAD

Hydrogen Fire Spectroscopy Issues

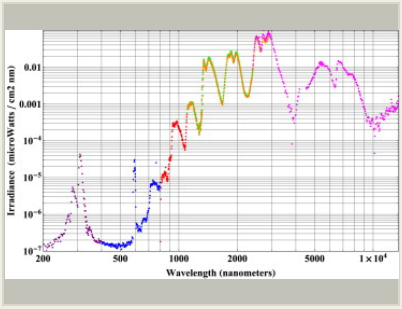
Completed Technology Project (2013 - 2014)

Project Introduction

The detection of hydrogen fires is important to the aerospace community. The National Aeronautics and Space Administration (NASA) has devoted significant effort to the development, testing, and installation of hydrogen fire detectors based on ultraviolet, near-infrared, mid-infrared, and/or far-infrared flame emission bands. Yet, there is no intensity calibrated hydrogen-air flame spectrum over this range in the literature and consequently, it can be difficult to compare the merits of different radiation-based hydrogen fire detectors.

This one year effort had four aspects; complete and document the calibrated spectral intensity of a hydrogen flame, understand the role of atmospheric attenuation on the performance of hydrogen flame detectors, help qualify the performance of the near infrared water measurement instrument used in the NASA Regolith and Environment Science and Oxygen and Lunar Volatile Extraction (RESOLVE) project, and build a prototype next-generation ultraviolet hydrogen flame simulator.

1. We obtained a calibrated ultraviolet lamp and worked with safety to permit its use. Using this we were able to calibrate our spectrometer for ultraviolet measurements and successfully measured the UV emission of a hydrogen flame. This completed our spectral measurement (we had previously performed measurements from the visible through the far-infrared under program funding). We have documented this effort in a new technology report and in a manuscript that we submitted to the International Journal of Hydrogen Energy. This paper has been accepted for publication and appeared in the June 2014 issue of the International Journal of Hydrogen Energy.
2. We set up an extended tube and filled it with humid air in order to perform some atmospheric absorption measurements. The results have indicated that the new infrared radiation (IR) fire detectors should operate within their design distance even in humid Florida air.
3. We have provided significant aid to the Resolve project. We took preliminary data before the spectrometer showed up, we performed analysis, we helped interpret the data provided by their spectrometer, and we've helped to develop an algorithm to convert their spectral absorbance data into a water vapor concentration.
4. We have designed, constructed, and tested a new prototype ultraviolet hydrogen flame simulator. A new technology report has been written and we will be working with KSC Ground Support Development to start the conversion of this device into ground support equipment so that it can be used to certify the ultraviolet fire detectors still being used in the field.



This is a compilation of the intensity calibrated hydrogen flame spectral data from 200 nm through 13,500 nm placed on a log-log plot allowing comparison of the magnitudes of the spectral peaks.

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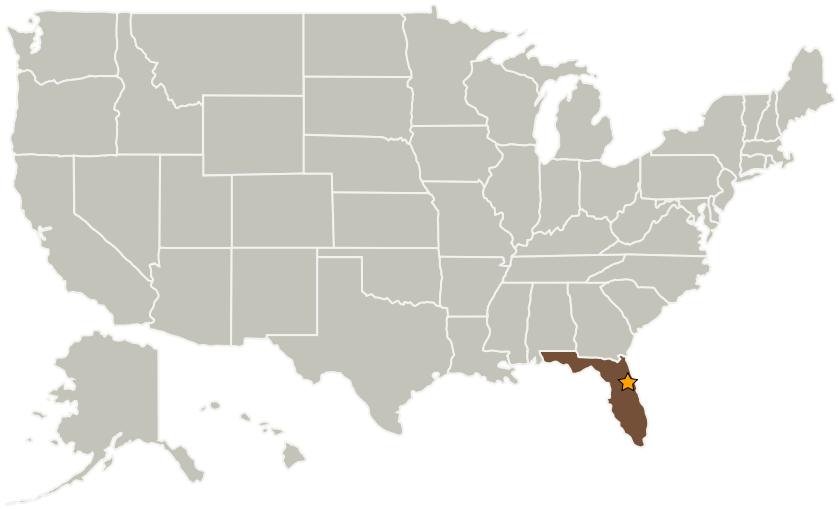
Anticipated Benefits

All missions that require a hydrogen fueled launch will benefit from this work. Having a better understanding of the emission spectrum of a hydrogen flame allows better design and evaluation of hydrogen flame detectors. Also, having a modernized ultraviolet hydrogen flame simulator will aid in the certification of the flame detection system at the launch pad being used.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida

Co-Funding Partners	Type	Location
Ground Systems Development and Operations Program(GSDO)	NASA Other	

Primary U.S. Work Locations
Florida

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Independent Research & Development: KSC IRAD

Project Management

Program Manager:

Barbara L Brown

Project Manager:

Pamela A Mullenix

Principal Investigator:

Robert C Youngquist

Co-Investigator:

Ellen E Arens

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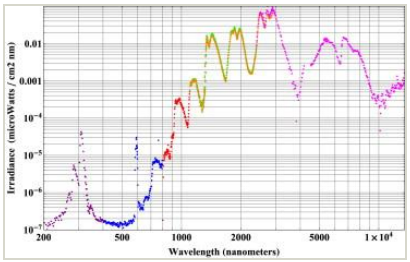
Images



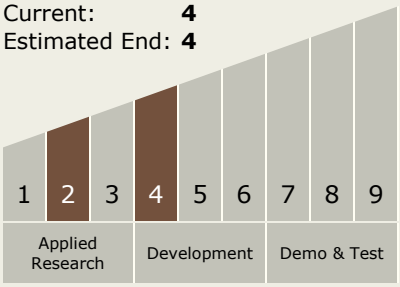
Compilation of Intensity Calibrated Hydrogen Flame Spectral Data
This is a compilation of the intensity calibrated hydrogen flame spectral data from 200 nm through 13,500 nm placed on a log-log plot allowing comparison of the magnitudes of the spectral peaks.
(https://techport.nasa.gov/image/4035)

Links

Intensity Calibrated Hydrogen Flame Spectrum
(http://www.sciencedirect.com/science/article/pii/S0360319914010647)

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.2 Test and Qualification
    - TX13.2.2 Propulsion, Exhaust, and Propellant Management